Air Quality in Ontario 1986 REPORT

Environment Ontario
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Minister

DATE DUE			

ANNUAL REPORT AIR QUALITY IN ONTARIO

...being a review of the Ministry of the Environment air quality monitoring program for 1986.

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SUMMARY

In 1986, the routine air monitoring programme in Ontario included the measurement of eight gases at up to 76 locations and the measurement of particulates at 142 locations.

For gases, the provincial criterion most frequently exceeded was that for ozone as the result of medium and long range transport from the United States. Out of 42 ozone stations monitored, 36 measured exceedances of the criterion at least once during the year. Exceedances for **sulphur dioxide, total reduced sulphur** and **nitrogen dioxide** occurred at some stations as well. The ten-year trends indicate improvement for sulphur dioxide, total reduced sulphur, carbon monoxide, nitrogen dioxide and nitric oxide, but little change in hydrocarbons and ozone.

For particulates, the 24-hour criterion for **total suspended particulate** was frequently exceeded. Ninety-seven out of 142 measured at least one exceedance during the year. Five stations measured exceedances of the criterion for **lead** and one station measured an exceedance for **nickel**. No other particulate criteria were exceeded. The ten-year trends show improvement in total suspended particulate as well as in each of the commonly monitored metals: copper, iron and lead.

The Air Pollution Index, which is the basis of the alert system for air pollution control in Ontario, had exceedances of the acceptable level of 32 at Hamilton only. There were five such occurrences in 1986 with a maximum API of 37 on May 15.

SOMMAIRE

Dans le cadre du programme régulier de surveillance de la qualité de l'air effectué en 1986 en Ontario, on a mesuré la concentration de huit gaz dans 76 lieux et la concentration des particules en suspension dans 142 endroits.

Les émissions d'ozone sont celles qui respectaient le moins souvent le critère provincial, en raison du transport d'ozone à longue et moyenne distance en provenance des États-Unis. Sur les 42 stations de surveillance de l'ozone, 36 ont enregistrée au **cours de l'année au moins un cas de dépassement du critère établi** pour l'ozone. De plus, on a mesuré dans certaines stations d'autres concentrations qui ne respectaient pas les critères établis : le dioxyde de soufre, le soufre total réduit et le dioxyde d'azote. Les tendances depuis dix ans montrent une **amélioration des concentrations de dioxyde de soufre, de soufre total réduit,** de monoxyde de carbone, de dioxyde d'azote et d'oxyde nitrique, mais peu d'amélioration en ce qui concerne les concentrations d'ozone et d'hydrocarbures.

En ce qui a trait aux particules, le critère de la concentration des particules en suspension en 24 heures a très **souvent été dépassé et notamment au moins une fois dans 98** stations sur 142 au cours de 1986. Cinq stations ont enregistré une concentration de plomb et une autre, de nickel. Aucun autre critère sur la concentration de particules n'a été dépassé. Depuis dix ans, on note une amélioration dans la concentration totale de particules en suspension et dans les métaux les plus fréquemment mesurés : le cuivre, le fer et le plomb.

L'Indice de pollution atmosphérique, indice de base du système de surveillance de la pollution atmosphérique en Ontario et dont le niveau acceptable a été fixé à 32, n'a été dépassé qu'à Hamilton. On a mesuré cinq cas de la sorte en 1986, dont le pire (IPA 37) le 15 mai.

INTRODUCTION

This report describes the 1986 Ontario air quality monitoring program including a summary of the measurements of gases and particulate matter during the year. It is intended for use in conjunction with an Appendix which appears in a separate volume.

In order to insure that the ambient air quality data are of the highest quality, the Air Resources Branch maintains a reference standards laboratory, where quality control and quality assurance programs reference standards to both the U.S. National Bureau of Standards as well as Environment Canada's Pollution Measurement Division. Quarterly performance audits of the monitoring equipment and the data acquisition system in the MOE network are also carried out.

For each pollutant, the following are discussed: characteristics of pollutant, effects, Ontario criteria (if any), sources, method of monitoring, locations (and frequency) of sampling, summary of sampling results, and ten-year trend.

Also, tables provide the location of stations and supply sample distribution information which includes means, maxima and the number of exceedances of the Ontario criteria.

The entire continuous (hourly) network is summarized in Appendix Table A-1. This table gives station name, numerical identifier, and an indication of the "continuous" pollutants measured. Letter codes indicate whether data are telemetered or chart-read.

The "continuous" pollutants include COH (co-efficient of haze) as well as the following gases:

SO_2 (sulphur dioxide)
CO (carbon monoxide)
O_3 (ozone)
NO_2 (nitrogen dioxide)
NO (nitric oxide)
NOx (total nitrogen oxides)
THC (total hydrocarbons)
RHC (reactive hydrocarbons)
TRS (total reduced sulphur)

Section A of this report describes each of the "continuous" pollutants in sequence. Section B deals with the Air Pollution Index over the past ten years.

The particulate (daily) network is summarized in Appendix Table A-3. This table provides station name, numerical identifier, and the various "daily" pollutants measured. Also, numerals indicate the monitoring cycle frequency in days. Some additional codes are defined in the key at the top of the table. The particulate pollutants are:

TSP (total suspended particulate)
Cd (cadmium)
Co (cobalt)
Cr (chromium)
Cu (copper)
Fe (iron)
Mn (manganese)
Ni (nickel)
Pb (lead)
V (vanadium)
NO_3^- (nitrate)
SO_4^{2-} (sulphate)

Section C describes each of the "daily" or particulate pollutants under the headings of TSP, Lead, Trace Metals, Nitrate and Sulphate.

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GLOSSARY

criterion – a recommended maximum ambient air exposure (based on effects)

detection limit – the minimum air concentration of a pollutant that can be determined by an analytical method

geometric mean – calculated by taking the nth root of the product of all (n) values in a data set
– provides a better indication than arithmetic mean of central tendency for a small data set with extreme values

percentile value – the percentage of the data set that lies below the stated value
– for example, if the 70 percentile value is 0.10 ppm, then 70% of the data are below 0.10 ppm

primary pollutant – a pollutant which is directly emitted to the atmosphere

secondary pollutant – a pollutant which is formed from other pollutants present in the atmosphere

"continuous" pollutant – a pollutant for which a continuous record exists; effectively pollutants which have hourly averaged data (maximum 8760 values per year)

"daily" pollutant – a pollutant for which there exists only a 24 hour or daily value (maximum 365 values per year)

ABBREVIATIONS

AQC – air quality criterion

ppb – parts (of pollutant) per billion (parts of air)

ppm – parts (of pollutant) per million (parts of air)

$\mu g/m^3$ – micrograms (of pollutant) per cubic metre (of air)

SECTION A POLLUTANTS MEASURED BY CONTINUOUS MONITORING (HOURLY DATA)

SO_2 SULPHUR DIOXIDE

1.1 Characteristics

Colourless gas. Strong, pungent odour over 0.5 ppm.

1.2 Effects

1 hour average

less than .16 ppm	— no known effects
.25 ppm	— injurious to sensitive species of vegetation
.34 ppm	— odourous, increasing vegetation damage
greater than 2.00 ppm	— increasing sensitivity of asthmatics and bronchitics

1.3 Ontario Criteria

.25 ppm (1 hour)
.10 ppm (24 hours)
.02 ppm (1 year)

Limiting effect — Health, vegetation.

1.4 Sources

80% of the SO_2 emitted in Ontario originates from non-ferrous smelters and electric utilities.

The rest comes from industrial sources including iron ore smelters, petroleum refineries, pulp and paper mills and area sources including vehicles and residential, commercial and industrial heating.

1.5 Method of Monitoring

Fluorescent excitation of SO_2 by pulsed ultra-violet radiation.

1.6 Locations of Monitoring

The Appendix provides a description of the provincial SO_2 network (Table A-1).

SO_2 monitoring was carried out at 76 locations in 1986.

1.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; and the maximum one hour and 24 hour values are provided in the Appendix (Table A-5). Also given are the number of exceedances of the sulphur dioxide criteria (see Section 1.3).

The lowest levels measured in the province once again were Thunder Bay Hospital and Hawkeye Lake where the hourly SO_2 never exceeded .01 ppm.

The greatest number of exceedances of the one hour criterion occurred at Balmertown (sewage treatment plant) and the highest annual mean was measured at Thorold.

There were a total of 18 stations which exceeded the hourly criterion at least once and five which exceeded the 24 hour criterion. No station exceeded the annual criterion. (See also Table 1).

1.8 Ten-Year Trend

The trend in mean annual SO_2 at locations which possess a ten-year record is shown in Table A-6 and is summarized for the province in Table 2.

Ambient SO_2 levels improved by about 60% over the ten-year period. This is primarily due to tighter industrial emission controls.

COH SOILING INDEX

2.1 Characteristics

A relative measure of suspended particulate matter of size most likely to reach the lungs (diameter less than 5-10 microns). Determined by the amount of soiling caused by air flow on a filter medium.

2.2 Effects

1 hour average

less than 2.0 COH units	— no known effects
2.0 COH units	— decrease in visibility
4.0 COH units	— soiling evident
6.0 COH units	— increasing sensitivity of asthmatics and bronchitics

2.3 Ontario Criteria

1.0 COH units/1000 feet (24 hours)
0.5 COH units/1000 feet (1 year)

Limiting effect — Health.

2.4 Sources

Industrial processes which include combustion, incineration, construction, mining, metal smelting and processing, grinding.

Natural sources include wind-blown soil, forest fires, ocean spray, volcanic activity.

2.5 Method of Monitoring

Continuous paper tape sampler with sampling inlet and flow rate regulated to favour small particles.

COH is determined by drawing a known volume of air through a portion of tape and then measuring the reduction in the light transmitted relative to a clean section of tape.

2.6 Locations of Monitoring

The Appendix provides a description of the provincial COH network (Table A-1).

Soiling Index was measured at 43 locations in 1986.

2.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; the maximum one hour and 24 hour values; and the number of exceedances of the COH criteria (see Section 2.3) are provided in the Appendix (Table A-7).

The lowest levels measured in the province were at Cornwall (Memorial Park) where the COH averaged 0.06 units.

The greatest number of exceedances of the 24 hour criterion occurred at the Mission (381 Yonge Street) in Toronto and the highest measured value was at Hamilton (Hughson/Hunter).

There were a total of 28 stations which exceeded the 24 hour criterion at least once and five which exceeded the one year criterion. (See also Table 1).

2.8 Ten-Year Trend

The trend in mean annual COH at selected Ontario cities is shown in Table A-8 and is summarized for the province in Table 2.

Despite some fluctuation, fine particulate, as determined by COH, has remained relatively constant over the past ten years.

TRS

TOTAL REDUCED SULPHUR

3.1 Characteristics

Primarily hydrogen sulphide (rotten egg odour). Also methyl mercaptans (rotten cabbage odour over 5 ppb).

3.2 Effects

1 hour average

less than 10 ppb	– no known effects
10 ppb	– odour threshold
27 ppb	– extremely odorous
1,000 ppb	sensitive individuals may suffer nausea and headache due to severe odour

3.3 Ontario Criteria

Hydrogen Sulphide – 27 ppb (1 hour) (provisional guideline)
Methyl mercaptans – 10 ppb (1 hour)
Limiting effect – Odour.

3.4 Sources

Industrial – pulp and paper mills, refineries. Natural – swamps, bogs, marshes.

3.5 Method of Monitoring

Reduced sulphur compounds are oxidized to SO_2 followed by fluorescent excitation by ultra-violet radiation.

3.6 Locations of Monitoring

The Appendix provides a description of the provincial TRS network (Table A-1).

TRS monitoring was carried out at 28 locations in 1986.

3.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; and the one hour and 24 hour maxima are provided in the Appendix (Table A-9).

The lowest levels measured in the province were at Tiverton in southwestern Ontario. The highest annual mean (7.3 ppb) and the greatest value measured (240 ppb) occurred at Cornwall (St. Peter's School). (See also Table 1).

3.8 Ten-Year Trend

Table A-10 shows the trend in mean annual TRS for selected Ontario cities while Table 2 shows the provincial trend. The trend indicates some improvement since 1979; the high variability in recent years results from the small number of stations with a ten year record.

CO

CARBON MONOXIDE

4.1 Characteristics

Colourless, odourless.

4.2 Effects 1 hour average

less than 30 ppm	– no known effects
30 ppm	– increased cardiovascular symptoms on smokers with heart disease
50 ppm	– increasing cardiovascular symptoms on non-smokers with heart disease. Some visual impairment.

4.3 Ontario Criteria

30 ppm (1 hour) 13 ppm (8 hours)
Limiting effect – Health.

4.4 Sources

Primary source (about 80%) is motor vehicles. A secondary source is fossil fuel combustion for building, heating and commercial/industrial operations.

4.5 Method of Monitoring

Non-dispersive infra-red photometry based on the preferential absorption of infra-red radiation by CO.

4.6 Locations of Monitoring

The Appendix provides a description of the provincial CO network (Table A-1). CO was monitored at 26 stations in 1986.

4.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; and the maximum one hour and eight hour values are given in the Appendix (Table A-11). The lowest levels measured in the province were at Ash Street in Sudbury and the highest mean was at the Mission (381 Yonge Street) in Toronto. The highest measured one hour and eight hour values were also at the Mission. There were no exceedances of the Ontario one hour criterion of 30 ppm however the Mission monitor registered 15 exceedances of the eight hour criterion. (See also Table 1.)

4.8 Ten-Year Trend

There has been a steady decline (about 60%) in ambient CO levels over the past ten years (see Tables 2 and A-12). This is due primarily to tighter controls on automotive emissions.

THC/RHC

HYDROCARBONS

5.1 Characteristics

Primarily methane (colourless, odourless) which is present at about 1.5 ppm in the ambient atmosphere. Non-methane hydrocarbons (or reactive hydrocarbons) are usually present at much lower levels. This fraction reacts with nitrogen oxides in the presence of sunlight to form ozone.

5.2 Effects

No known effects at ambient levels.

5.3 Ontario Criteria

None.

5.4 Sources

Natural sources include trees and other vegetation and decay of animal and plant material.

Anthropogenic sources include motor vehicles, gasoline storage tanks, petroleum and chemical industries.

5.5 Method of Monitoring

Calibrated flame ionization dectector

5.6 Locations of Monitoring

The Appendix provides a description of the provincial THC/RHC network (Table A-1).

RHC was monitored at seven stations while THC was monitored at 10 locations in 1986.

5.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; and the maximum one hour and 24 hour values are given in the Appendix (Tables A-13 and A-15).

The locations and values for the lowest, and highest means are given in Table 1. St. Catharines (North/Geneva Street) measured the highest maximum concentration of reactive hydrocarbon for the year.

The highest total hydrocarbon value for the year was measured at the Elmcrest Road monitor in Etobicoke.

5.8 Ten-Year Trend

The trend in THC at the 7 stations which have a ten year record is shown in Table A-14 and is summarized for the province in Table 2. Apart from a temporary "dip" in 1979 and 1980, THC shows no clear trend.

NO_2

NITROGEN DIOXIDE

6.1 Characteristics

Brown gas. Pungent, irritating odour over .12 ppm.

Oxidation product of nitric oxide (NO) which is the primary NO_x emission. Reacts with hydrocarbons in sunlight to form ozone; and with water to form nitric acid, a component of acid rain.

6.2 Effects

1 hour average

less than .10 ppm	– no known effects
.10 ppm	– odour threshold
.25 ppm	– some increase in bronchial reactivity in asthmatics
.52 ppm	– increasing sensitivity of asthmatics and bronchitics

6.3 Ontario Criteria

.20 ppm (1 hour)
.10 ppm (24 hours)

Limiting effect – Health.

6.4 Sources

Anthropogenic – high temperature combustion processes including automobiles, power plants, incinerators and several chemical processes. In Ontario, transportation accounts for about 60% of total NO_x emissions.

Natural – lightning, soil bacteria.

6.5 Method of Monitoring

Based on the principle of chemiluminescence involving a gas phase reaction of NO with ozone. For NO_2, the sample stream is passed through a catalytic converter where NO_2 is reduced to NO.

6.6 Locations of Monitoring

The Appendix provides a description of the provincial NO_2 network (Table A-1).

NO_2 monitoring was carried out at 31 locations in 1986.

6.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; and the maximum one hour and 24 hour values are provided in the Appendix (Tables A-16). Also given are the number of exceedances of the nitrogen dioxide criteria (see Section 6.3).

The lowest levels measured in the province were at Hawkeye Lake where the arithmetic mean was .000 ppm.

The highest annual mean was measured at the Junction Triangle in Toronto.

There were two stations which exceeded the one hour criterion, however the 24 hour criterion was not exceeded during 1986. (See also Table 1).

6.8 Ten-Year Trend

The ten-year trend in NO_2 at selected Ontario cities is shown in Table A-17. Table 2 shows that an improvement in NO_2 has occurred since 1977, which primarily relates to tighter automotive emission controls.

NO

NITRIC OXIDE

7.1 Characteristics

Colourless gas. Oxidizes to NO_2 in the presence of hydrocarbons and sunlight.

7.2 Effects

No known effects at ambient levels.

7.3 Ontario Criteria

None.

7.4 Sources

Same as for NO_2.

7.5 Method of Monitoring

Same as for NO_2.

7.6 Locations of Monitoring

Same as for NO_2.

7.7 Monitoring Results

Long Point Provincial Park had the lowest mean; the Mission in Toronto, the highest. (See Appendix Table A-18 for the data summaries.)

7.8 Ten-Year Trend

A reduction in NO since the mid-1970's (see Tables 2 and A-19) relates largely to tighter automotive emission controls.

NO_x

TOTAL NITROGEN OXIDES

8.

NO_x is assumed to be the sum of NO_2 and NO concentrations in the atmosphere (in parts per million). Normally this assumption is valid. (See Appendix Table A-20 for the data summaries.)

O_3

OZONE

9.1 Characteristics

Colourless gas. Major component of photochemical oxidant compounds formed as the result of chemical reactions between nitrogen oxides and reactive hydrocarbons in the presence of sunlight.

9.2 Effects

1 hour average

less than 50 ppb	– no known effects
80 ppb	– injurious to many species of vegetation
120 ppb	– decreasing performance by athletes exercising heavily
200 ppb	– decrease in lung function in exercising subjects, eye irritation

9.3 Ontario Criteria

80 ppb (1 hour)

Limiting effect – Health, vegetation.

9.4 Sources

Ozone is produced by photochemical reactions and not directly emitted into the atmosphere. Since it is formed downwind of nitrogen oxide and hydrocarbon sources and capable of travelling long distances through the atmosphere, ozone is a major manifestation of the long range transport of air pollution. Its formation and transport are dependent on meteorological factors.

9.5 Method of Monitoring

An air sample reacts with ethylene to emit visible light (chemiluminescence) of intensity directly proportional to the ozone concentration.

9.6 Locations of Monitoring

The Appendix provides a description of the provincial O_3 network (Table A-1).

Ozone monitoring was carried out at 42 locations in 1986.

9.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; and the maximum one hour and 24 hour values are provided in the Appendix (Table A-21). Also given are the number of exceedances of the ozone criterion (see Section 9.3).

The lowest levels measured in the province were at the Science Centre in North York where the arithmetic mean was 7.4 ppb.

The greatest number of exceedances of the one hour criterion occurred at Long Point Provincial Park and the highest mean concentration for the year was recorded there also.

There were a total of 36 stations which exceeded the criterion at least once. The highest measured concentration was 140 ppb at Parkhill in Southwestern Ontario.

9.8 Ten-Year Trend

Table A-22 provides the ten-year trend for 0_3 at the stations where a ten-year record exists. Table 2 summarizes the data for the province. Despite some variability at specific sites, the provincial mean has remained relatively constant.

TABLE 1 – HIGHLIGHTS OF CONTINUOUS MONITORING 1986

	SO_2	COH	TRS	CO	THC	NO_2	NO	O_3
LOWEST MEAN								
Location	Thunder Bay (63022) Hawkeye Lake (63100)	Cornwall (56051)	Tiverton (18007)	Sudbury (77016)	Toronto (31104)	Hawkeye Lake (63100)	Long Point (22901)	North York (34002)
Concentration	0 ppb	.06 units	0.1 ppb	0.1 ppm	1.61 ppm	0 ppb	0 ppb	7.4 ppb
HIGHEST MEAN								
Location	Thorold (27052)	Toronto (31049)	Cornwall (56071)	Toronto (31049)	London (15001)	Toronto (31120)	Toronto (31049)	Long Point (22901)
Concentration	12 ppb	.69 units	7.3 ppb	3.5 ppm	2.80 ppm	34 ppb	94 ppb	31.4 ppb
MOST CRITERIA EXCEEDANCES-1 HR								
Location	Balmertown (61014)	N/A	Cornwall (56071)	–	N/A	S.S. Marie (71066)	N/A	Long Point (22901)
Number	79	N/A	607	0	N/A	2	N/A	165
MOST CRITERIA EXCEEDANCES-24 HRS								
Location	Walden (77201)	Toronto (31049)	N/A	N/A	N/A	–	N/A	N/A
Number	3	40	N/A	N/A	N/A	0	N/A	N/A
NUMBER OF STATIONS EXCEEDING 1 HR AQC								
Number	18	N/A	20	0	N/A	2	N/A	36
NUMBER OF STATIONS EXCEEDING 24 HR AQC								
Number	5	28	N/A	N/A	N/A	0	N/A	N/A
HIGHEST MEASURED VALUE-1 HR								
Location	Thorold (27042)	Hamilton (29001)	Cornwall (56071)	Toronto (31049)	Etobicoke (35003)	S.S. Marie (71066)	Toronto (31049)	Parkhill (15013)
Concentration	1290 ppb	4.9 units	240 ppb	27 ppm	15.1 ppm	310 ppb	950 ppb	140 ppb
TOTAL NUMBER OF STATIONS								
Number	76	43	28	26	10	31	31	42

TABLE 2 – TEN-YEAR TREND FOR "CONTINUOUS" POLLUTANTS

POLLUTANT (UNITS)	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	TOTAL NUMBER OF STATIONS
SO_2 (ppb)	12	10	9	8	7	7	5	6	6	5	18
COH	0.36	0.36	0.38	0.32	0.33	0.36	0.33	0.37	0.32	0.32	11
TRS (ppb)	2.1	2.3	2.8	2.5	2.3	2.1	2.0	1.5	1.0	1.6	4
CO (ppm)	1.4	1.2	1.1	0.9	1.0	0.9	0.7	0.7	0.7	0.6	13
THC (ppm)	2.22	2.18	1.87	1.87	2.03	2.09	2.12	2.23	2.24	2.14	7
NO_2 (ppb)	27	26	22	21	20	20	19	20	19	20	15
NO (ppb)	24	23	22	17	22	17	17	20	18	19	15
O_3 (ppb)	20	23	20	20	19	20	20	20	21	19	18

SECTION B
THE ONTARIO AIR POLLUTION INDEX (API)

10.1 Characteristics

The API is the basis of an alert system to warn of deteriorating air quality and is derived from 24 hour running averages of sulphur dioxide and soiling index. Research studies have linked respiratory illness to high concentrations of sulphur dioxide and particulates.

10.2 Legislation

The Ontario Environmental Protection Act (1971) authorizes the Minister of the Environment to order any source not essential to public health or safety to curtail or cease its operations when air pollution levels which may be injurious to health occur.

10.3 Operation of the System

The API is computed each hour based on the past 24 hourly values for SO_2 and COH. If the index reaches a value of 32 (as for example when $SO_2 = 0.1$ ppm and COH = 1.0) and if the Duty Meteorologist predicts a continuation of adverse atmospheric conditions for at least six hours, an Air Pollution Advisory is issued. Owners of significant sources of pollution are advised to prepare for possible curtailment of operations.

If the index reaches 50, and if at least six hours of adverse atmospheric conditions are forecast, owners of major sources will be ordered to curtail operations. This is the First Alert Level.

A Second Alert is issued at an API of 75, and further curtailment may be ordered.

The Air Pollution Episode Threshold Level occurs at an API of 100. If atmospheric conditions are not expected to improve for at least six hours, owners of all sources not essential to public health or safety will be ordered to cease operations.

10.4 Air Pollution Index Levels (1977-1986)

A history of the Air Pollution Index over the last 10 years of its operation is provided in Table 3.

TABLE 3
ONTARIO'S AIR POLLUTION INDEX

Date Started:			
	TORONTO	Mar. 23, 1970	
	HAMILTON	June 15, 1970	
	SUDBURY	Jan. 16, 1971	
	WINDSOR (12008)	Mar. 19, 1971	
	WINDSOR (12016)	Mar. 1, 1975	
	WELLAND	Jan. 1, 1974	(Closed after 1978)
	NIAGARA FALLS	Nov. 1, 1974	
	CONISTON	Feb. 18, 1975	
	NEW SUDBURY	Mar. 1, 1976	
	SARNIA	Dec. 1, 1977	
	ST. CATHARINES	Sep. 14, 1979	

YEAR	CITY	NUMBER OCCASIONS ≥ 32	NUMBER OCCASIONS ≥ 50	MAXIMUM INDEX	DATE OF MAXIMUM
1977	TORONTO	4	0	36	Jan. 15
	HAMILTON	10	0	44	Mar. 12
	SUDBURY	0	0	24	June 11
	WINDSOR (12008)	1	0	33	Apr. 19
	WINDSOR (12016)	0	0	29	Apr. 19
	WELLAND	0	0	22	Jan. 24, 25
	NIAGARA FALLS	0	0	28	Feb. 21
	CONISTON	0	0	25	Apr. 25
	NEW SUDBURY	1	0	39	June 11
	SARNIA	0	0	15	Dec. 13
1978	TORONTO	2	0	45	Nov. 5
	HAMILTON	7	0	43	Nov. 4
	SUDBURY	0	0	31	Jan. 22
	WINDSOR (12008)	1	0	33	Apr. 19
	WINDSOR (12016)	0	0	28	Feb. 18
	WELLAND	0	0	24	Mar. 15
	NIAGARA FALLS	0	0	23	Nov. 4, Mar. 11
	CONISTON	3	0	34	Feb. 7
	NEW SUDBURY	1	0	42	Feb. 2
	SARNIA	3	0	41	Jan. 24
1979	TORONTO	2	0	35	Oct. 18
	HAMILTON	23	1	55	Dec. 22
	SUDBURY	0	0	18	July 7
	WINDSOR (12008)	0	0	31	Feb. 20
	WINDSOR (12016)	0	0	27	Feb. 21
	NIAGARA FALLS	0	0	27	Feb. 21
	CONISTON	0	0	31	Feb. 14
	NEW SUDBURY	0	0	28	Feb. 14
	SARNIA	2	0	43	Feb. 20
	ST. CATHARINES	0	0	29	Nov. 6

TABLE 3

ONTARIO'S AIR POLLUTION INDEX

YEAR	CITY	NUMBER OCCASIONS ≥ 32	NUMBER OCCASIONS ≥ 50	MAXIMUM INDEX	DATE OF MAXIMUM
1980	TORONTO	0	0	31	Dec. 8
	HAMILTON	5	0	40	Oct. 16
	SUDBURY	0	0	23	Oct. 16
	WINDSOR (12008)	0	0	25	Feb. 8, 9
	WINDSOR (12016)	0	0	25	Dec. 29
	NIAGARA FALLS	0	0	18	May 24
	CONISTON	0	0	30	Feb. 10, Mar. 9
	NEW SUDBURY	0	0	24	Jul. 3, Oct. 16
	SARNIA	1	0	39	Mar. 20
	ST. CATHARINES	0	0	28	Feb. 20
1981	TORONTO	3	0	43	Nov. 14
	HAMILTON	8	0	38	Nov. 15
	SUDBURY	0	0	21	Jan. 31
	WINDSOR (12008)	1	0	42	Nov. 17
	WINDSOR (12016)	0	0	31	Nov. 17
	NIAGARA FALLS	0	0	25	Jan. 14
	CONISTON	0	0	20	Nov. 25
	NEW SUDBURY	0	0	22	Jan. 28-29
	SARNIA	1	0	34	Feb. 16
	ST. CATHARINES	0	0	27	Jan. 14-15
1982	TORONTO	3	2	54	Oct. 27
	HAMILTON	12	0	39	Dec. 2
	SUDBURY	0	0	15	Feb. 3
	WINDSOR (12008)	0	0	31	Oct. 26-27
	WINDSOR (12016)	1	0	35	Oct. 27
	NIAGARA FALLS	0	0	19	Jan. 19
	CONISTON	1	0	39	Feb. 5
	NEW SUDBURY	0	0	29	Feb. 5
	SARNIA	0	0	27	Mar. 11, Nov. 7-8
	ST. CATHARINES	0	0	31	Nov. 18
1983	TORONTO	3	0	39	Jan. 29
	HAMILTON	1	0	37	Mar. 2
	SUDBURY	1	0	39	Jan. 22
	WINDSOR (12008)	0	0	26	Sep. 27
	WINDSOR (12016)	1	0	33	Mar. 1-2
	NIAGARA FALLS	0	0	17	Jan. 30
	CONISTON	0	0	19	Jan. 15
	NEW SUDBURY	1	1	63	Jan. 22
	SARNIA	0	0	28	Jan. 29
	ST. CATHARINES	0	0	23	Jan. 30
1984	TORONTO	2	1	50	Jan. 16
	HAMILTON	8	0	44	Nov. 27
	SUDBURY	0	0	23	Feb. 1
	WINDSOR (12008)	0	0	31	Oct. 2, Nov. 14
	WINDSOR (12016)	1	0	40	Feb. 15
	NIAGARA FALLS	0	0	20	Dec. 10-11
	CONISTON	0	0	29	Nov. 22
	NEW SUDBURY	0	0	23	Nov. 22
	SARNIA	0	0	27	Jan. 23
	ST. CATHARINES	0	0	24	Feb. 10-11
1985	TORONTO	0	0	25	Apr. 23
	HAMILTON	2	0	36	Apr. 23-24
	SUDBURY	0	0	31	Aug. 4
	WINDSOR (12008)	0	0	25	Dec. 20
	WINDSOR (12016)	0	0	30	Dec. 20
	NIAGARA FALLS	0	0	19	Apr. 24
	CONISTON	0	0	19	Mar. 26
	NEW SUDBURY	0	0	31	Jan. 7
	SARNIA	0	0	20	Mar. 27-28
	ST. CATHARINES	0	0	18	Dec. 6
1986	TORONTO	0	0	22	Jan. 17
	HAMILTON	5	0	37	May 15
	SUDBURY	0	0	23	Oct. 26
	WINDSOR (12008)	0	0	31	Jan. 16, Oct. 22, Dec. 16
	WINDSOR (12016)	0	0	29	Mar. 14
	NIAGARA FALLS	0	0	17	Jan. 17
	CONISTON	0	0	18	Mar. 20-21
	NEW SUDBURY	0	0	20	Apr. 23
	SARNIA	0	0	29	Dec. 17
	ST. CATHARINES	0	0	18	Jan. 17

SECTION C POLLUTANTS MEASURED BY HIGH VOLUME SAMPLER MONITORING (DAILY DATA)

TSP

TOTAL SUSPENDED PARTICULATE

11.1 Characteristics

Suspended particulate is a generic term for airborne particles including smoke, fume, dust, fly ash and pollen. Composition varies with place and season but normally includes soil particulates, organic matter, sulphur and nitrogen compounds and metals such as lead. Size range is approximately .1 to 100 microns (10^{-6} metres diameter).

11.2 Effects

The greatest impact on health is from particles less than 10 microns in diameter which can penetrate deep into the lungs and contribute to respiratory disease. More serious health effects may be associated with suspended particulate matter which contains a toxic particulate component or which has adsorbed a gaseous pollutant on the surface of the particles. Corrosion, soiling, damage to vegetation and visibility reduction are additional effects.

11.3 Ontario Criteria

120 $\mu g/m^3$ (24 hours)
60 $\mu g/m^3$ (1 year – geometric mean)

Limiting effect – Health.

11.4 Sources

Natural sources include wind-blown soil, forest fires and plant pollen. Anthropogenic sources include combustion, incineration, construction, mining, metals smelting and processing, grinding processes, agricultural activity and transportation.

11.5 Method of Monitoring

By High Volume Sampler. Air is drawn through a filter at the rate of approximately 1.4 m^3/min. The (daily) mass concentration of total suspended particulate matter is computed from the mass of collected particles and the volume of air sampled.

11.6 Location and Frequency of Monitoring

The monitoring locations and the length of the sampling cycle (in days) for each location are indicated in the Appendix (Table A-3).

TSP was measured at 142 locations in 1986.

11.7 Monitoring Results

The distribution by percentile; the maximum; the arithmetic and geometric means are given in the Appendix (Table A-23). Also given are the number of exceedances of the 24 hour and one year criteria.

The lowest levels measured in the province were at the Hospital in Blind River where the annual mean was 20 $\mu g/m^3$.

The greatest number of exceedances of the 24 hour criterion occurred at Hamilton (Beach Boulevard) and the highest annual mean was measured at Thorold.

There were a total of 97 stations which exceeded the 24 hour criterion and 38 which exceeded the one year criterion. (See also Table 4.)

11.8 Ten-Year Trend

The trend in mean annual TSP at locations which possess a ten-year record is shown in Table A-24 and is summarized for the province in Table 5. Particulate levels have improved since 1977 by about 15%.

Pb

LEAD IN SUSPENDED PARTICULATE

12.1 Characteristics

A silver bluish, white, soft metal. Molecular weight 207.20.

12.2 Effects

Can degrade renal function, impair hemoglobin synthesis, and alter the nervous system.

12.3 Ontario Criteria

5.0 $\mu g/m^3$ (24 hours)
2 $\mu g/m^3$ (30 day – geometric mean)

Limiting effect – Health.

12.4 Sources

Combustion of gasoline containing lead additives, secondary smelting of lead, battery manufacture, metal fabrication, some paint and glass manufacture, production of iron, steel, copper and nickel.

Lead emissions fell significantly after 1975 with the introduction of lead-free gasoline.

12.5 Method of Monitoring

Lead concentration on high volume filters determined by either X-Ray fluorescence or atomic absorption.

12.6 Location and Frequency of Monitoring

The monitoring locations and the length of the sampling cycle (in days) for each location are indicated in the Appendix (Table A-3).

Lead was measured at 81 locations in 1986.

12.7 Monitoring Results

The distribution by percentile; the maximum; the arithmetic and geometric means are given in the Appendix (Table A-25). Also given are the number of exceedances of the criteria.

The lowest lead levels in the province occurred at several rural locations including Mooretown, Corunna and Nanticoke.

The greatest number of exceedances of the 24 hour criterion occurred at Mississauga (2414 Dixie Road) in the vicinity of a lead processing plant. The highest annual mean and the highest measured value occurred at this location as well.

There were a total of five stations which exceeded the daily criterion at least once. (See also Table 4.)

12.8 Ten-Year Trend

Lead levels in air improved by about 60% during the six year period 1977 to 1982 but have remained relatively constant for the past 5 years (see Table 5).

The trend at selected Ontario cities is shown in Table A-26; the decline is largely due to the increasing use of unleaded gasoline.

TRACE METALS

CADMIUM, COBALT, CHROMIUM, COPPER, IRON, MANGANESE, NICKEL, VANADIUM

13.1 Chacteristics

Name	Symbol	Properties	Molecular Weight
Cadmium	Cd	silver white, hexagonal	112.41
Cobalt	Co	silver grey, cubic	58.93
Chromium	Cr	steel grey, cubic	52.00
Copper	Cu	red, cubic	63.55
Iron	Fe	silver, cubic	58.85
Manganese	Mn	grey-pink, cubic	54.94
Nickel	Ni	silver, cubic	58.69
Vanadium	V	light grey, cubic	50.94

13.2 Effects

Depth of penetration into the respiratory system and, consequently, risk to health increase as particle size diminishes. The shape and chemical composition of the particles are additional factors.

13.3 Ontario Criteria

	24 Hour Criterion		Limiting Effects
Cadmium	2	($\mu g/m^3$)	Health
Chromium	1.5	($\mu g/m^3$)	Health
Copper	50	($\mu g/m^3$)	Health
Manganese	50	($\mu g/m^3$)	Health
Nickel	2	($\mu g/m^3$)	Vegetation
Vanadium	2	($\mu g/m^3$)	Health

13.4 Sources

See Section 1.4.

13.5 Method of Monitoring

Collection is by High Volume Sampler (see Section 11.5). Following determination of TSP, a strip is cut from the exposed filter and ashed to destroy carbonaceous matter. The ashed sample is then digested in acid, and analyzed by atomic absorption spectrophotometry. The mass concentration of each metal in ambient air is calculated from the mass of each metal in TSP and the volume of air sampled, and expressed in $\mu g/m^3$.

13.6 Location and Frequency of Sampling

The monitoring locations and the length of the sampling cycle (in days) for each location are indicated in the Appendix (Table A-3).

Metals were measured at 62 to 68 stations depending on the element.

13.7 Monitoring Results

The distribution by percentile of the daily data; the maximum; the arithmetic mean; the geometric mean; and the number of exceedances of the daily criterion are provided in the Appendix for Copper, Iron, Manganese, Nickel, Chromium, Cadmium and Vanadium. No table is provided for Cobalt where a large percentage of the measurements were below the detection limit. However, the maximum monitored levels for *all* trace metals are shown in Table A-36.

Table 4 provides the Highlights of Particulate Monitoring for 1986. It shows that two exceedances of the air quality criteria for metals (exclusive of lead) occurred in 1986. Both exceedances occurred at Copper Cliff and the metal was nickel. Such exceedences may be harmful to vegetation.

13.8 Ten-Year Trend

The trend in mean annual Copper and Iron is shown in Tables A-28 and A-30, respectively, and is summarized for Ontario in Table 5. Copper has declined by 30% and Iron by 40% over the past ten years.

NO_3^-

NITRATE

14.1 Characteristics

Nitrogen oxide compounds, formed from atmospheric nitrogen and oxygen through high temperature combustion, photochemical reactions or bacterial action, may react with other compounds in the air to form nitrate (NO_3^-) or nitric acid (HNO_3).

14.2 Effects

Nitrate and nitric acid are involved in corrosion of materials, visibility degradation and acidic precipitation. They may also have an adverse effect on human health.

14.3 Ontario Criteria

None.

14.4 Sources

Nitrate is primarily a secondary pollutant. Anthropogenic sources of nitrogen oxides or nitrates include all high temperature combustion processes, transportation, and fertilizer production and usage. Natural sources include lightning, biological decomposition and photochemical reaction.

14.5 Methods of Monitoring

Nitrates collected on glass fibre filters by a High Volume Sampler are extracted by digestion in distilled water. This extract is reduced to nitrite followed by colourimetric analysis for determination of the mass concentration of atmospheric nitrate.

14.6 Location and Frequency of Monitoring

The monitoring locations and the length of the sampling cycle (in days) for each location are indicated in the Appendix (Table A-3).

Nitrate monitoring was carried out at 63 locations in 1986.

14.7 Monitoring Results

The distribution by percentile; the maximum; the arithmetic mean; and the geometric mean are given in the Appendix (Table A-37). Highlights of monitoring are summarized in Table 4.

The highest annual mean nitrate concentration occurred at Hamilton (Hughson/Hunter St.) while the highest concentration for a single day occurred at the Hamilton (Cumberland Avenue) monitor.

14.8 Ten-Year Trend

The trend in mean annual NO_3 at locations which possess a ten-year record is shown in Table A-38 and is summarized for the province in Table 5.

Since nitrate is frequently formed in the ambient atmosphere, its variability is related to meteorological variability.

SO_4^{2-} SULPHATE

15.1 Characteristics

Sulphur dioxide is oxidized in the atmosphere to eventually form sulphate compounds. Intermediaries in the oxidation process such as HSO_3 and SO_3 rapidly combine with water vapour to form sulphuric acid aerosol. This type of process is dependent on atmospheric conditions.

15.2 Effects

Sulphate compounds have been linked to respiratory irritation and disease, corrosion of materials, reduction of visibility and the formation of acidic precipitation.

15.3 Ontario Criteria

None.

15.4 Sources

Sulphate is primarily a secondary pollutant. Anthropogenic sources of sulphur oxides include the burning of fuels containing sulphur (such as coal and oil), the smelting of sulphur-containing metals and the refining of petroleum. Natural sources include bacterial decomposition, volcanoes and forest fires.

15.5 Method of Monitoring

Sulphate collected on glass fibre filters by a High Volume Sampler is extracted by digestion in distilled water. This extract is analyzed colourimetrically and the mass concentration of sulphate is calculated.

15.6 Location and Frequency of Monitoring

The monitoring locations and the length of the sampling cycle (in days) for each location are indicated in the Appendix (Table A-3).

Sulphate monitoring was carried out at 63 locations in 1986.

15.7 Monitoring Results

The distribution by percentile; the maximum; the arithmetic mean; and the geometric mean are given in the Appendix (Table A-39). Highlights of monitoring are summarized in Table 4.

The highest annual mean sulphate concentration was measured at Hamilton (Burlington/Leeds), and the highest concentration for a single day occurred at Hamilton (Hughson/Hunter).

15.8 Ten-Year Trend

The variability of the annual means for sulphate (see Tables 5 and A-40) may be explained by meteorological variability as in the case of nitrate (Section 14.8).

TABLE 4 – HIGHLIGHTS OF PARTICULATE MONITORING 1986

	TSP	Pb	Cu	Fe	Mn	Ni	NO_3^-	SO_4^{2-}
LOWEST MEAN								
Location	Blind River (71065)	Several	London (15015)	Several	Several	Several	Timmins (72077)	Thunder Bay (63022) (63040)
Concentration	20 µg/m³	0.1 µg/m³	.01 µg/m³	0.2 µg/m³	.007 µg/m³	.001 µg/m³	0.4 µg/m³	2.8 µg/m³
HIGHEST MEAN								
Location	Thorold (27052)	Mississauga (46041)	Copper Cliff (77070)	Hamilton (29011)	Hamilton (29011)	Copper Cliff (77070)	Hamilton (29001)	Hamilton (29011)
Concentration	144 µg/m³	2.4 µg/m³	.44 µg/m³	4.8 µg/m³	.388 µg/m³	.183 µg/m³	4.5 µg/m³	12.5 µg/m³
MOST CRITERIA EXCEEDANCES-24 HRS								
Location	Hamilton (29102)	Mississauga (46041)		N/A		Copper Cliff (77070)	N/A	N/A
Number	69	93	0	N/A	0	2	N/A	N/A
NUMBER OF STATIONS EXCEEDING 24 HR AQC								
Number	97	5	0	N/A	0	1	N/A	N/A
NUMBER OF STATIONS EXCEEDING 1 YR AQC								
Number	38	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HIGHEST MEASURED VALUE-24 HRS								
Location	Thorold (27052)	Mississauga (46041)	Copper Cliff (77070)	Hamilton (29001)	Hamilton (29001)	Copper Cliff (77070)	Hamilton (29087)	Hamilton (29001)
Concentration	731 µg/m³	27.0 µg/m³	9.86 µg/m³	38.0 µg/m³	2.39 µg/m³	2.29 µg/m³	42.4 µg/m³	50.0 µg/m³
TOTAL NUMBER OF STATIONS								
Number	142	81	62	68	65	64	63	63

TABLE 5 – TEN-YEAR TREND FOR PARTICULATE POLLUTANTS

POLLUTANT (UNITS)	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	TOTAL NUMBER OF STATIONS
TSP (µg/m³)	55	56	62	61	53	49	47	48	43	46	26
Pb (.1 µg/m³)	5	4	3	3	3	2	2	2	2	2	14
Cu (.01 µg/m³)	22	24	23	25	19	17	21	18	17	15	18
Fe (.1 µg/m³)	12	13	11	12	8	7	7	7	8	7	18
NO_3^- (.1 µg/m³)	21	32	35	32	31	31	29	29	28	27	16
SO_4^{2-} (.1 µg/m³)	79	81	104	105	91	83	81	82	68	74	16